

SECTION 21

ELECTRICAL DISTRIBUTION AND STREETLIGHTING
SYSTEM; UNDERGROUND

21-01. SOCPE: The work covered by this section of the specifications consists in furnishing all plant, labor, equipment, appliances, and materials, not furnished by the Government, and in performing all operations in connection with the installation of the underground electrical-distribution and street lighting system, complete, in strict accordance with this section of the specifications and the applicable drawings, and subject to the terms and conditions of the contract.

21-02. APPLICABLE SPECIFICATIONS: The following specifications and standards, of the issues listed below but referred to thereafter by basic designation only, form a part of this specification:

a. Federal Specifications:

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| J-C-121 | Cable and Wire; Rubber Insulated, for Other than Building Purposes |
| W-C-571 | Conduit and Fittings; Asbestos-Cement (for) Electrical Purposes |
| W-C-581a | Conduit and Fittings; Fiber, Bituminized |
| W-C-601a | Connectors, Wire; Pressure, Solderless (for Electric Cable and Wire) |
| W-E-406 | Fittings; Cable and Conduit |
| HH-T-10a | Tape; Friction |
| HH-T-11c | Tape; Rubber |
| QQ-L-652 | Iron, Gray; Castings |
| WW-C-581a | Conduit; Steel, Rigid, Zinc-Coated |

b. Association of Edison Illuminating Companies Specification:

Impregnated Paper Insulated, Lead Covered Cable, 7th Edition

c. National Electrical Manufacturer's Association:

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| 42-83 | High Voltage Insulator Standards |
| 48-132 | Transformer Standards |
| 49-144 | Power Switching Equipment Standards |
| 49-145 | Distribution Cut-Outs, Power Fuses and Current-Limiting Resistor Standards |

e. Insulated Power Cable Engineer Association Specification:

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| S-19-81 | Wires and Cables with Rubber, Rubber-like and Thermoplastic Insulation |
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21-03 GENERAL: The distribution and street lighting system shall be complete with all necessary accessories for proper operation. The disconnecting devices protective devices and all other equipment shall be thoroughly coordinated to secure the required results with the greatest assurance of protection to life and property consistent with these specifications. The contract drawings indicate the extent and general arrangement of the distribution and street lighting system. If any departures from the contract drawings are deemed necessary by the Contractor, details of such departures and the reasons therefor shall be submitted as soon as practicable to the Contracting Officer for approval. No such departures shall be made without the prior written approval of the Contracting Officer.

a. Standard Products: The equipment to be furnished under this specification shall be essentially the standard product of approved American manufacturer. Where two or more units of the same class of equipment are required these units shall be the products of a single manufacturer; however, the component parts of the equipment need not be the products of the same manufacturer.

b. Materials and Equipment: Within 45 days after the date of award of contract and before purchase of any materials or equipment, a complete schedule, in triplicate, of Contractor-furnished materials and equipment proposed for installation shall be submitted to the Contracting Officer for approval. The schedule shall include catalogs, cuts drawings, diagrams, and such other descriptive data as may be required by the Contracting Officer. In the event any of the items of materials and equipment contained in the schedule fail to comply with the requirements of the specifications, such items may be rejected. If the Contractor fails to submit, prior to the expiration of the above specified period or any authorized extension thereof, a schedule of materials and equipment acceptable to the Contracting Officer, the Contracting Officer may select and designate the materials and equipment, all of which shall be furnished and installed by the Contractor without change in contract price or time of completion.

21-04 MATERIALS AND EQUIPMENT: Materials and equipment shall conform to the respective specifications and other requirements specified below:

a. Asbestos-Cement Conduit: Federal Specification W-C-571, type I, for concrete encasement.

b. Cable and Conduit Fittings: Federal Specification W-F-406.

c. Fiber Conduit: Federal Specification W-C-581, type I, for concrete encasement.

d. Steel Conduits: Federal Specification W-C-581.

e. Ground Rods: Ground rods shall be copper clad steel as manufactured by the Copperclad Steel Corporation or approved equal.

f. Tape: Federal Specification HH-T-101, or HH-T-111.

21-05 DUCT SYSTEM: The duct system shall consist of single, round-bore, fiber or asbestos-cement conduit for the electrical-distribution system and the telephone system. The number and size of duct shall be as indicated on the drawings. In order to provide drainage for the duct line, they shall be laid with a minimum grade of 4 inches per 100 feet. Grade may be from one manhole to the next or both ways from a high point between manholes, depending on the contour of the finished grade. Duct line shall be installed so that the top of concrete is not less than 2 feet below finished grade or finished paving. Trenching and backfilling shall conform to the applicable requirements of section on EARTHWORK, GENERAL, of these specifications. Where duct lines enter manholes, the conduits shall terminate in end bells. Ducts shall be thoroughly cleaned before laying. Excavations shall be backfilled and well tamped, and excess excavation shall be deposited as directed by the Contracting Officer. During construction and after the duct line is completed, the ends of the ducts shall be plugged to prevent water washing mud into the ducts. Particular care shall be taken to keep the conduits clear of concrete or any other substance during the course of construction. After the duct line has been completed, a mandrel not less than 12 inches long, having a cross section approximately 1/4 inch less than the inside cross section of the conduit shall be pulled through to make certain that no particles of earth, sand or gravel have been left in the line. Where a connection is to be made to an existing duct which is of different material and shape than the duct being installed, a suitable coupling of a type recommended by the duct manufacturer shall be used.

a. Installation of Duct Banks Comprising Single Conduits:

Each single conduit shall be completely encased in concrete. Thickness of concrete between fiber or asbestos-cement conduits shall be not less than 2 inches. The thickness of outside concrete encasement shall be not less than 3 inches, except under roads or parking areas. Under roads and parking areas, concrete encasement shall be reinforced and as shown on Standard Drawing No. 40-06-01, Sheet 3 or its latest revision. Joints in conduits shall be staggered at least 6 inches. Tapered ends of fiber or asbestos-cement conduits shall be swabbed with bituminous compound before coupling is applied to insure a watertight joint.

b. Installation of Single-Duct Laterals: Single-duct laterals installed for primary distribution system cables shall be completely encased in concrete. The thickness of concrete shall be not less than 3 inches on the sides, bottom and top of the conduit. Concrete encasement under roads crossing or parking areas shall be reinforced in accordance with standard drawing referred to in the preceding subparagraph. Tapered ends of fiber or asbestos-cement conduits shall be swabbed with a bituminous compound before coupling is applied in order to ensure a watertight joint.

c. Concrete: Concrete shall be plain except where reinforced concrete is indicated on the drawings. Plain and reinforced concrete shall conform to the requirements of Section on CONCRETE of these specifications. Duct lines shall be of monolithic construction. Spacing blocks shall be made of concrete. Where a connection is to be made to an existing duct line, the concrete encasement shall be well bonded to the existing encasement.

21-06 MANHOLES: Manholes shall be constructed approximately where shown on the drawings. The exact location of each manhole shall be determined after careful consideration has been given to the location of other utilities, grading and paving. The location of each manhole shall be approved by the Contracting Officer or his authorized representative before construction of the manhole is commenced. Manholes shall be of type noted and shall be constructed in accordance with the applicable details shown or referred to on the drawings. Top, walls, and bottom of manholes shall be composed of reinforced concrete. Walls, bottom and sump shall be of monolithic construction. Concrete, forms, mixing, pouring, and reinforcing bars shall conform to the requirements of Section on CONCRETE of these specifications. Frames and covers shall be made of gray cast-iron conforming to the requirements of Federal Specification QQ-L-652. A machine-finished seat shall be provided to ensure a perfect joint between the frame and cover. Frames and covers shall be delivered on the job unpainted and after inspection and approval by the Contracting Officer, they shall be given 2 coats of asphalt paint. In unpaved areas the top of manhole covers shall be approximately 1/2 inch above the finished grade. In paved areas the top of manhole covers shall be flush with the finished surface of the paving. Cables shall be well supported on walls by hot-galvanized cable strips equipped with adjustable hooks and insulators. At least 2 cable strips shall be installed in each manhole and not less than 2 spare hooks shall be installed on each cable strip. Insulators shall be made of best-quality, high-glazed porcelain. Insulators will not be required on the spare hooks. A cable pulling iron shall be installed in the wall opposite each duct line entrance into the manhole. In each manhole, at a convenient point close to the wall, a 3/4 inch copper or copper-clad steel ground rod shall be driven into the earth not less than 6 feet before the manhole floor is poured. The ground rod shall extend approximately 6 inches above the manhole floor. Ground rods installed for the electrical distribution system manholes shall be properly connected to neutral and cable sheaths by means of No. 0 AWG, uninsulated, stranded, copper cable. Connection to cable sheaths shall be by means of tin terminals soldered to the ground wire and cable sheath. Care shall be taken in soldering not to damage the lead sheath. The ground wire shall be neatly and firmly attached to the manhole walls. Cables for the telephone system will be installed by others. The Contractors, however, shall provide cable strips, pulling irons and ground rods, as specified above, in each telephone manhole except that each cable strip shall be provided with 2 hooks and that no insulators will be required. Where duct lines enter manholes the sections of duct may either be cast in the concrete or enter the manhole through a square or rectangular opening of suitable dimensions provided in the manhole wall. Where openings are provided for the entrance of duct lines the space between ducts and between ducts and manhole walls shall be calked tight with lead wool.

21-07. PRIMARY CABLE SYSTEM: The primary cable system shall consist of paper-insulated, lead-covered cables as indicated on the drawings. The size and number of conductors and the number of cables shall be as indicated on the drawings. Conductor larger than No. 8 AWG shall be stranded. Cables shall have voltage rating, phase to phase, of at least 15,000 volts and shall be shielded. Cables rated 15,000 volts shall be insulated for use in ungrounded neutral circuit and thickness of paper insulation shall be not less than that indicated in the following table:

Round Conductors

| | | | | | | |
|-------------------|---------------|-----|-----|-----|-----|---------------|
| Size - AWG | - - - - - 4 | 3 | 2 | 1 | 1/0 | 2/0 or larger |
| Thickness - Mills | - - - - - 255 | 245 | 240 | 225 | 220 | 215 |

Conductors No. 2/0 AWG or larger may be sector conductors and thickness of paper insulation for sector conductor shall be not less than 215 mills. Except as otherwise specified hereinbefore, cables shall conform to the applicable requirements of the 7th edition of the Specifications for Impregnated Paper-Insulated, Lead Covered Cable of the Association of Edison Illuminating Companies, including all tests specified therein. Cables shall be installed in duct lines and manholes. No splice shall be made except in manholes. No cable shall be pulled through any manhole without splicing, except where a manhole is located within 50 feet of the cable terminal or as otherwise specifically authorized by the Contracting Officer. Cable splices shall be made by qualified cable splicers in strict accordance with the recommendations of the cable manufacturer and/or the applicable details shown on Standard Drawing No. 40-06-01, Sheet 26, or its latest revisions as listed in these specifications. The qualification of each cable splicer shall be approved by the Contracting Officer before cable splicing is started. Loads shall be divided as evenly as practicable on the various phases of the system.

21-08 GROUNDING: Non-current-carrying metallic parts of equipment and neutral conductors, shall be grounded at each transformer installation as shown on the drawings and/or as hereinafter specified. An underground metallic water pipe, connected to a water supply system and having a nominal diameter of one inch or larger, should be used for grounding wherever ground connection can be made at a point which will be accessible for future inspection, such as directly inside of a building or not in excess of 2 feet below the ground. Where a water pipe of suitable size and location is not available, 3/4-inch copper or copper-clad steel ground rods, driven into the earth at least 8 feet, shall be used for grounding. The total ground resistance shall not exceed 10 ohms. If this resistance cannot be obtained with a single ground rod, a sufficient number of additional rods shall be installed so that the resultant resistance will be within that limit. The distance between ground rods, shall be not less than 6 feet. Ground conductors shall be copper wire, cable, or bus bar of the size indicated on the drawings. Ground conductors shall be installed in a neat and workmanlike manner and shall be securely held in place by means of straps placed at proper intervals. Connections in the grounding system shall be made by means of solderless connectors, except where solder type lugs are furnished on equipment.

21-09 TRANSFORMER HOUSES: Transformer houses shall be constructed in accordance with the applicable drawings and the applicable sections of the specifications and as herein specified. Houses shall be provided with roofing in accordance with the section on ROOFING. Except as otherwise shown on the drawings or specified herein all electrical equipment and wiring in the transformer houses shall conform to recommended practices and adopted standards of the National Electrical Manufacturer's Association. Transformers shall be of the ratings indicated on the drawings. However primary wiring and accessories shall be rated for use on 13.8 kv line.

a. Doors and Door-frames: Doors shall be flush hollow metal of the sizes indicated on the drawings and unless otherwise indicated therein, shall be constructed of 16-gage pressed steel tubing, patent leveled, full pickled and free from blisters, pits, burns and other defects, reinforced with rolled sections framed in a rigid construction. Hollow spaces between metals shall be filled with approved treated insulating material. Joints shall be filled, reinforced, welded and ground smooth to produce invisible seams. Sinkages shall be cut for mortise or countersunk hardware. Steel reinforcing plates of ample size shall be provided and properly secured back of the sinkage cuts to stiffen the metal. The plates shall be drilled and tapped accurately to the hardware templates. Metal boxes shall be provided in the back of all cutouts for hardware. Doors shall be prefitted to its hardware and frames at the factory prior to shipment. Door frames shall be of the sizes and design shown on the drawings and shall be fabricated of same material as the doors, 12-gage thickness unless otherwise indicated on the drawings. Corners of frames shall be reinforced and may be mitered and welded their full length, and dressed off flush in the exposed surface. Mitters shall be well formed and in true alignment. The finished frame shall be strong and rigid, neat in appearance and free from defects, and shall have adjustable steel anchors for each jamb spaced approximately 2 ft. on centers. Doors and frames shall be galvanized. Hardwares shall be as indicated on the drawings.

21-10 POTHEADS: Potheads shall be of the capnut type, and shall be suitable for conductors of the gage and type used. Potheads shall have cast-iron bells. Bell caps shall be made of cast brass or other non-magnetic material for cables larger than 4/0 AWG. Insulators shall be made of high-glazed porcelain of the outdoor type. The voltage rating of potheads for use on systems operating at distribution system voltages in excess of 4,500 volts shall be not less than 15,000 volts. The dry flashover voltage of 15,000-volt indoor potheads shall be as indicated on the drawings but in no case less than 75,000 volts. Stuffing boxes shall form a positive seal, preventing the leakage of compound under high ambient temperatures. Potheads shall be completely filled with insulating compound of such nature that when heated it will flow into every part of the terminal and completely fill it, leaving no gap or air spaces. The compound used shall be of a type recommended by the pothead manufacturer. In heating the compound a thermometer shall be inserted to prevent overheating.

21-11 TRANSFORMERS: Transformers shall be of the ratings indicated on the drawings.

21-12 PRIMARY FUSE CUT-OUTS: Primary fuse cut-outs shall have a voltage rating of at least 15,000 volts. Fuses shall have a continuous rating equal to approximately 150 percent of the full-load line current when used for transformer protection. Interrupting capacities shall be as indicated on the drawings. Primary fuse cut-outs shall conform to the requirements of the National Electrical Manufacturers Association Standard for Fuse Cut-outs and Power Fuses.

21-13 INSULATORS: Insulators of applicable type and method of mounting shall be installed as required to support properly open wiring. Unless otherwise indicated on the drawings, the distance between insulators shall not exceed 4 feet. Insulators shall be made of high-glazed porcelain and shall conform to the requirements of the National Electrical Manufacturers Association Standard 42-83. The dry flashover voltage of indoor insulators for use on circuits operating at 13,800 volts shall be not less than that indicated on the drawings. Insulators shall be radio-free.

21-14 SECONDARY CABLE SYSTEM: Secondary cables shall be polychloroprene sheathed cable suitable for direct burial. The size and number of conductors and the number of cables shall be indicated on the drawings. Secondary cables shall be rated not less than 600 volts and conductors larger than No. 8 AWG shall be stranded. Direct-burial cables shall be buried directly in the ground at least 2 feet below finished grade except under roads or paved areas. Under roads or paved areas the direct-burial cable shall be installed in concrete encased fiber or asbestos cement conduit.

a. Polychloroprene Sheathed Cable: Conductor and insulation shall conform to the applicable requirements of Federal Specification J-C-121. Coverings and sheath shall conform to the applicable requirements of the Insulated Power Cable Engineers Association Specifications for Wires and Cables with Rubber, Rubber-Like and Thermoplastic Insulation, Polychloroprene, grade 2.

(1) Splices: Buried splices will not be permitted in runs of 500 feet or less and at intervals of less than 500 feet in longer runs, except as required to avoid damage to cable or obstruction. Buried splices in cables shall be made in cast iron, compound filled, splice boxes or as shown on the drawings. Splicing shall be accomplished to provide insulation and other characteristics equal to the insulation and sheath of the cable. Connectors shall be of the solderless type, conforming to the requirements of Federal Specification W-C-601a.

b. Trenching and Backfilling: Trenching and backfilling shall conform to the requirements of the section on EARTHWORK, GENERAL of these specifications except that a cushion of approved sand not less than 3 inches thick shall be provided around the non-metallic sheathed cable unless otherwise noted on the drawings.

21-15 STREET-LIGHTING STANDARDS: Street-lighting standards shall be of the design and type indicated on the drawings and shall be made of cast-iron conforming to Federal Specifications QQ-I-652.

The standards shall be securely mounted with a concrete foundation as shown on the drawings. Concrete shall be class B and shall conform to the applicable requirements of the section on CONCRETE of these specifications.

21-16 STREET LIGHTING LUMINAIRES: Street-lighting luminaires shall be of the globe type as indicated on the drawings. The general appearance of the luminaires shall be such that they will harmonize with the casing and column to which they will be attached. Each luminaire shall be provided with a refractor, and socket as specified on the drawings. The lamp shall be mounted base down. The assembly of the luminaire shall be such as to give ready access for inspection, replacement of equipment, and cleaning. Luminaires shall be water-tight. Screws and nuts shall be made of bronze, brass, or other nonferrous material. The luminaires shall be designed to provide uniform distribution of light along the street with a maximum cut-off above the horizontal and on the building side of the unit. The unit shall be firmly held at the bottom by a globe holder to which shall be attached upright supports, not less than 5/16 inch thick, holding a strong removable, ornamental band so as to encase the globe. The globe shall be made of high-quality rippled glass of a density sufficient to make the filament of the lamp invisible, with an absorption of light not exceeding 15 percent. Globes shall be carefully tempered to withstand sudden changes in temperature and for high mechanical strength. The canopy shall be of glass of the same character as the globe, shall have graceful lines tapering to an ornamental finial, and shall be securely supported by the metal framework independently of the globe. The globe holder and luminaire framework shall be made of cast bronze. Soft gaskets shall be installed at the top and bottom of the globe, at the bottom of the canopy, and between the canopy and finial. The gaskets shall be not less than 1/16 inch thick, shall be securely cemented to the luminaire metal, and shall form a perfect seat for the globe and canopy. Not less than 4 strong, adjustable spring catches shall be provided to hold the globe and canopy securely in place. Spring catches shall provide a resilient grip in order to reduce breakage due to wind, vibration, or expansion of the glass.

21-17 SERVICE CONNECTION TO BUILDING: Service cables shall be extended into the building as indicated on the drawings and shall be properly connected to the main service equipment, switches or potheads as applicable. Empty conduits from a point outside the building to the main service equipment, switches or potheads will be as specified on the section on ELECTRICAL WORK INTERIOR of these specifications. Loads shall be divided as evenly as practicable on the various phases of the system.

21-18 JOINT USE OF TRENCHES: Wherever no communication ducts from the manholes and transformer stations to buildings are indicated on the drawings to be included in this contract, ample opportunity shall be given the signal services to install communication cables or ducts in the power cable trenches before backfilling. Proper clearances shall be provided as indicated on standard drawings.

21-19 TESTS: After the installation is completed, and at such time as the Contracting Officer may direct, the Contractor shall conduct an operating test for approval. The equipment shall be demonstrated to operate in accordance with the requirements of these specification. The test shall be performed in the presence of the Contracting Officer or his authorized representative. The Contractor shall furnish all instruments and personnel required for the test, and the Government will furnish the necessary electrical power.